WE CLAIM:

1. A method of generating complementary masks for use in a multiple-exposure lithographic imaging process, said method comprising the steps of:

identifying a target pattern having a plurality of features, said plurality of features comprising horizontal and vertical edges,

generating a horizontal mask based on said target pattern,

generating a vertical mask based on said target pattern, and

performing a shielding step in which at least one of the vertical edges of the plurality of features in the target pattern is replaced by a shield in the horizontal mask, and in which at least one of the horizontal edges of the plurality of features in the target pattern is replaced by a shield in the vertical mask, said shields having a width which is greater that the width of the corresponding feature in the target pattern.

2. The method of generating complementary masks according to claim 1, further comprising:

performing an assist feature placement step in which sub-resolution assist features are disposed parallel to at least one of the horizontal edges of the plurality of features in the horizontal mask, and are disposed parallel to at least one of the vertical edges of the plurality of features in the vertical mask., and

performing a feature biasing step in which at least one of the horizontal edges of the plurality of features in the horizontal mask are adjusted such that the resulting feature accurately reproduces the target pattern, and at least one of the vertical edges of the plurality of features in the vertical mask are adjusted such that the resulting feature accurately reproduces the target pattern.

3. The method of generating complementary masks according to claim 1, wherein prior to said shielding step said horizontal mask and said vertical mask are identical to said target pattern.

4. The method of generating complementary masks according to claim 1, further comprising the steps of:

defining a system pseudo-intensity function, said system pseudo-intensity function approximating the imaging performance of said multiple-exposure lithographic imaging process, and

determining the amount of shielding to be applied in said shielding step by evaluating said system pseudo-intensity function utilizing said target design.

5. The method of generating complementary masks according to claim 4, wherein said system pseudo-intensity function is determined utilizing one of a calibrated model of the multiple-exposure lithographic imaging process or a theoretical model of the multiple-exposure lithographic imaging process.

6. The method of generating complementary masks according to claim 2, wherein said assist feature placement step is performed prior to said shielding step.

7. An apparatus for generating complementary mask patterns for use in a multiple-exposure lithographic imaging process, said apparatus comprising:

means for identifying a target pattern having a plurality of features, said plurality of features comprising horizontal and vertical edges,

means for generating a horizontal mask based on said target pattern,

means for generating a vertical mask based on said target pattern, and

means for performing shielding in which at least one of the vertical edges of the plurality of features in the target pattern is replaced by a shield in the horizontal mask, and in which at least one of the horizontal edges of the plurality of features in the target pattern is replaced by a shield in the vertical mask, said shields having a width which is greater that the width of the corresponding feature in the target pattern.

8. An apparatus for generating complementary masks according to claim 7, further comprising:

means for performing an assist feature placement in which sub-resolution assist features are disposed parallel to at least one of the horizontal edges of the plurality of features in the horizontal

mask, and are disposed parallel to at least one of the vertical edges of the plurality of features in the vertical mask, and

means for performing a feature biasing in which at least one of the horizontal edges of the plurality of features in the horizontal mask are adjusted such that the resulting feature accurately reproduces the target pattern, and at least one of the vertical edges of the plurality of features in the vertical mask are adjusted such that the resulting feature accurately reproduces the target pattern.

9. An apparatus for generating complementary masks according to claim 7, wherein prior to said shielding said horizontal mask and said vertical mask are identical to said target pattern.

10. An apparatus for generating complementary masks according to claim 7, further comprising:

means for defining a system pseudo-intensity function, said system pseudo-intensity function approximating the imaging performance of said multiple-exposure lithographic imaging process, and

means for determining the amount of shielding to be applied in said shielding by evaluating said system pseudo-intensity function utilizing said target design.

11. An apparatus for generating complementary masks according to claim 10, wherein said system pseudo-intensity function is determined utilizing one of a calibrated model of the multiple-exposure lithographic imaging process or a theoretical model of the multiple-exposure lithographic imaging process.

12. An apparatus for generating complementary masks according to claim 8, wherein said assist feature placement is performed prior to said shielding.

13. A method for printing a pattern on a substrate utilizing dipole illumination, said pattern having a plurality of features comprising horizontal and vertical edges, said method comprising the steps of:

generating a horizontal mask based on said target pattern,

generating a vertical mask based on said target pattern, and

performing a shielding step in which at least one of the vertical edges of the plurality of features in the target pattern is replaced by a shield in the horizontal mask, and in which at least one of the horizontal edges of the plurality of features in the target pattern is replaced by a shield in the vertical mask, said shields having a width which is greater that the width of the corresponding feature in the target pattern.

14. The method for printing a pattern according to claim 13, further comprising:

performing an assist feature placement step in which sub-resolution assist features are disposed parallel to at least one of the horizontal edges of the plurality of features in the horizontal mask, and are disposed parallel to at least one of the vertical edges of the plurality of features in the vertical mask., and

performing a feature biasing step in which at least one of the horizontal edges of the plurality of features in the horizontal mask are adjusted such that the resulting feature accurately reproduces the target pattern, and at least one of the vertical edges of the plurality of features in the vertical mask are adjusted such that the resulting feature accurately reproduces the target pattern.

15. The method for printing a pattern according to claim 13, wherein prior to said shielding step said horizontal mask and said vertical mask are identical to said pattern.

16. The method for printing a pattern according to claim 13, further comprising the steps of:

defining a system pseudo-intensity function, said system pseudo-intensity function approximating the imaging performance of said multiple-exposure lithographic imaging process, and

determining the amount of shielding to be applied in said shielding step by evaluating said system pseudo-intensity function utilizing said target design.

17. The method for printing a pattern according to claim 16, wherein said system pseudo-intensity function is determined utilizing one of a calibrated model of the multiple-exposure lithographic imaging process or a theoretical model of the multiple-exposure lithographic imaging process.

18. The method for printing a pattern according to claim 14, wherein said assist feature placement step is performed prior to said shielding step.

19. A computer program product for controlling a computer comprising a recording medium readable by the computer, means recorded on the recording medium for directing the computer to generate files corresponding to complementary masks for use in a multiple-exposure lithographic imaging process, said generation of said files comprising the steps of:

identifying a target pattern having a plurality of features, said plurality of features comprising horizontal and vertical edges,

generating a horizontal mask based on said target pattern,

generating a vertical mask based on said target pattern, and

performing a shielding step in which at least one of the vertical edges of the plurality of features in the target pattern is replaced by a shield in the horizontal mask, and in which at least one of the horizontal edges of the plurality of features in the target pattern is replaced by a shield in the vertical mask, said shields having a width which is greater that the width of the corresponding feature in the target pattern.

20. The computer program product of claim 19, wherein said generation of said files further comprises:

performing an assist feature placement step in which sub-resolution assist features are disposed parallel to at least one of the horizontal edges of the plurality of features in the horizontal mask, and are disposed parallel to at least one of the vertical edges of the plurality of features in the vertical mask., and

performing a feature biasing step in which at least one of the horizontal edges of the plurality of features in the horizontal mask are adjusted such that the resulting feature accurately reproduces the target pattern, and at least one of the vertical edges of the plurality of features in the vertical mask are adjusted such that the resulting feature accurately reproduces the target pattern.

21. The computer program product of claim 19, wherein prior to said shielding step said horizontal mask and said vertical mask are identical to said target pattern.

22. The computer program product of claim 19, wherein said generation of said files further comprising the steps of:

defining a system pseudo-intensity function, said system pseudo-intensity function approximating the imaging performance of said multiple-exposure lithographic imaging process, and

determining the amount of shielding to be applied in said shielding step by evaluating said system pseudo-intensity function utilizing said target design.

23. The computer program product of claim 22, wherein said system pseudo-intensity function is determined utilizing one of a calibrated model of the multiple-exposure lithographic imaging process or a theoretical model of the multiple-exposure lithographic imaging process.

24. A device manufacturing method comprising the steps of:

(a) providing a substrate that is at least partially covered by a layer of radiation-sensitive material;

(b) providing a projection beam of radiation using a radiation system;

(c) using patterning means to endow the projection beam with a pattern in its cross-section;

(d) projecting the patterned beam of radiation onto a target portion of the layer of radiation-sensitive material,

wherein steps (c) and (d) are performed a first time with a first pattern and then a second time with a second pattern, said first and second patterns being generated using a method according to claim 1.